METHOD AND ARRANGEMENT FOR IMPROVED INTER-RAT HANDOVER

TECHNICAL FIELD

The invention relates to communication networks in general, and specifically to handover between different radio access technologies.

BACKGROUND

Throughout the world, third-generation mobile services are being introduced. As a consequence, a plurality of different radio access technologies (RAT) coexists, e.g. TDMA, WCDMA, CDMA2000, WLAN etc.

In order to enable almost seamless services for the end-users, third generation mobile terminals are equipped with so called dual RAT, e.g. both WCDMA (Wideband Code-Division Multiple Access) and GSM technology (Global System for Mobile communications) i.e. TDMA, whereby the mobile terminal is able to communicate with both RAT. Likewise, the mobile terminal and the radio access network have to be able to support handover between the two technologies.

Handover between networks utilizing different RAT require that a dual-mode user equipment or mobile terminal, while communicating over a first radio access network utilizing a first RAT, has to perform measurements on neighboring cells in a second radio access network utilizing a second RAT.

Depending on the type of network, either the mobile terminal itself decides when to change from one cell to another, or the decision is performed at a network node such as a base station controller in the first network. The later case suggests that the mobile terminal has to report some measured parameters to the base station.

During handover from a GSM network to a network utilizing WCDMA e.g. UTRAN, the mobile transmits a standardized measurement report to the base station controller of the GSM network. Consequently, the base station controller, based on the received measurement report, decides to which target UTRAN cell the handover will be effected.

Various problems are associated with such inter-RAT handovers, typically due to the inherent differences in the radio access technologies.

SUMMARY

A general object of the present invention is to provide an improved handover between different radio access technologies.

A further object is to provide a method for improved inter-RAT handover to radio access networks utilizing WCDMA.

Yet another object is to provide a method for stable handover performance during variations in traffic load.

The above mentioned objects and other objects are achieved with the present invention.

The main aspect of the present invention is to enhance the UTRAN/WCDMA measurements in the Measurement result message sent from a multi-RAT mobile, so that both a first parameter e.g. the Ec/No value and a second parameter e.g. the RSCP value are included. The base station controller will then have the possibility to use both measures to make an optimal UTRAN handover decision. This will make the handover performance more optimized and stable during traffic load variations.

The advantage of this invention is that the handover to UTRAN decision will be optimized. The decision will be more independent of the traffic load situation, and the implementation can be made in such a way that the operator can select to trigger UTRAN handover based on Ec/No measurements, RSCP measurements, or both.

This invention improves the reporting from Mobile Stations/User Equipment sent to the BSC in GSM mode, by including both quality and Signal strength measurements of WCDMA/UTRAN neighbors.

Advantages of the present inventions include:

- Improved measurement report
- Stable handover
- Optimized handover decision
- Prevented ping-pong handover

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

Fig. 1 is a schematic block diagram of a communication system in which the present invention can be utilized,

Fig. 2 is a schematic diagram illustrating how RSCP and E_c/No varies with the distance from a base station,

Fig. 3 is a flow diagram of an embodiment of a method according to the invention,

Fig. 4 is a schematic block diagram of an embodiment of a mobile equipment according to the invention, and

Fig. 5 is a schematic block diagram of an embodiment of a node in a radio access network according to the invention.

DETAILED DESCRIPTION

Frequently mentioned abbreviations are listed below:

Ec/No	Chip Energy divided by Noise
HO	HandOver
IRAT	Inter Radio Access Technology
MS	Mobile Station
RSCP	Received Signal strength per chip
UE	User Equipment
RXQUAL	Received Signal Quality
RXLEV	Received Signal Level
CPICH	Common Pilot Channel

In order to fully appreciate the merits of the present invention a more in-depth identification and description of the problems with prior art will be described below.

Referring to FIG. 1, consider a user with a dual-mode mobile terminal 3, also referred to as mobile node, mobile station, wireless unit or user equipment, communicating with over a GSM network 1. At the same time the user equipment 3 measures quality parameters for a plurality of neighboring cells or radio base stations 20 in a UTRAN network 2. The measurements can be performed continuously, or at predetermined time intervals.

According to prior art an existing dual-mode mobile terminal or user equipment 3 measures and reports only the UTRAN quality measure CPICH Ec/No of neighboring UTRAN cells when communicating in GSM mode. (Ref. 3GPP 04.18.) The existing GSM measurement report is used and the measured CPICH Ec/No value is reported for one or more UTRAN cells.

Referring to FIG.2, the present invention is based on the recognition that the existing solution, where the user equipment 3 reports only the Ec/No values, has some important drawbacks. The main problem is that the E_c/No and the RSCP values have little or no correlation, but are both important for the quality.

FIG. 2 illustrates schematically how both the Ec/No and the RSCP values vary as functions of the distance from a measured base station. RSCP typically has an exponentially decreasing behavior, more or less independent on the load situation of the base station. The Ec/No decreases slowly until it drops abruptly, resulting in a pronounced knee on the curve. Also, Ec/No is load dependent (since No is a measure of the power density in the band) and as a result the curve is displaced downward when the traffic load increases.

Consequently, both the Ec/No and the RSCP value at a certain geographical location can be very good at a low traffic load in the network, while the same spot may show a quite bad Ec/No value at a higher traffic load (and the RSCP value is still good) (see point A in FIG. 2). Or, the Ec/No may be very good and the RSCP may be bad at low traffic load (see point B in FIG. 2). In especially new UTRAN markets where the traffic load most probably will change quite substantially, this will cause a problem to define an optimal GSM to UTRAN (GTU) handover parameter setting.

Field Trial activities have proven that the above problems exist, and that an optimal GSM to UTRAN handover decision cannot be guaranteed based on only the Ec/No value. This may cause dropped calls due to too low signal strength in downlink or uplink.

In present implementations of UTRAN to GSM, it is also possible to base the handover decision on RSCP values. However, since the GSM to UTRAN decision is based solely on Ec/No this may cause unbalanced handover borders, resulting in so called ping-pong handovers, or unnecessary large hysteresis areas.

In order to overcome the above mentioned problem, and provide a more stable handover for GSM to UTRAN the present invention proposes a solution wherein also the RSCP value is measured and reported to the base station controller of the first radio access network.

An embodiment of a method according to the invention will be described with reference to FIG.1 and FIG. 3.

A mobile terminal 3 communicates with a node such as a base station controller 10 in a GSM network 1 and performs, in a first step S1, measurements on neighboring radio base stations 20 or cells of a UTRAN network 2 utilizing WCDMA radio access technology. The mobile terminal 3 measures first and second parameters for neighboring UTRAN cell 20.

According to the invention, the measured first parameter comprises information relating to the quality of the received signal at the user equipment 3. Preferably, the first parameter represents the energy per chip over noise (Ec/No). Also, according to the invention, the second parameter comprises information relating to the strength of the received signal at the user equipment 3. Preferably, the second parameter represents the received signal code power (RSCP).

In a second step S2, the mobile terminal 3 reports the measured first and second parameters for each neighboring UTRAN cell 20 to the GSM base station controller 10. According to a first embodiment of the invention, the mobile terminal 3 reports both parameters for each cell at the same time. According to another embodiment of the invention, the mobile terminal 3 reports the values alternately to the base station controller 10.

In a third step S3; the base station controller 10 receives the measured first and second parameters for each neighboring UTRAN cell 21.

Subsequently, in a fourth step S4, according to the invention, the node or base station 10 or typically the base station controller, based on the received first and second parameters selects which UTRAN cell 20 from the plurality of neighboring UTRAN cells 20 that should be the target cell and consequently receive the handover.

Preferably, the UTRAN cell 20 with the combination of the highest values for both of said two parameters is selected. However, it is understood that some other selection algorithm can be utilized in order to determine the handover.

Consequently, in a fifth step S5, the base station controller 10 initiates the handover to said selected target UTRAN cell 20.

Finally, the handover is completed.

Conventional procedures for handover and synchronization are not part of the invention, and therefore not described in any detail.

According to another embodiment of the method according to the invention the reporting step S2 is performed by including the measured parameters in a measurement report (as defined by 3GPP-standard), such as the Measurement Report of 3GPP TS 04.18.

The existing Measurement Report message specified in the 3GPP TS 04.18 includes fields for GSM RXQUAL values, or UTRAN/WCDMA Ec/No values. The message can, according to the invention, be modified to include both Ec/No and RSCP, or alternating Ec/No or RSCP values. The RXLEV-NCELL n field (where 'n' is one of the 6 reported neighbors) consists of 6 bits. See Table1 below.

The *Measurement Results* is a type 3 information element with 17 octets length.

Table 1: Measurement report

8	7	6	5	4	3	2	1	
	Measurement Results IEI							octet 1
BA-USED	DTX USED	RXLEV-FULL-SERVING-CELL						octet 2
3G-BA-USED	MEAS-VALID	RXLEV-SUB-SERVING-CELL						octet 3
0 spare	RXQUAL-FULL SERVING-CELL			RXQUAL-SUB SERVING-CELL			NO-NCELL M (high part)	octet 4
NO-NCELL-M (low part)	RXLEV-NCELL 1							octet 5
BCCH-FREQ-NCELL 1						BSIC-NCELL 1 (high part)		octet 6
BSIC-NCELL 1 (low part)			RXLEV-NCELL 2 (high part)					octet 7
RXLEV NCELL 2 (low part)	BCCH-FREQ-NCELL 2					BSIC-NCELL 2 (high part)		octet 8
BSIC-NCELL 2 (low part)				RXLEV-NCELL 3 (high part)				octet 9
RXLEV-NCELL 3 (low part)	BCCH-FREQ-NCELL 3						BSIC-NCELL 3 (high part)	octet 10

BSIC-NCELL 3 (low part)	RXLEV-NCELL 4 (high part)	octet 11
RXLEV-NCELL 4 (low part)	BCCH-FREQ-NCELL 4	octet 12
BSIC-NCELL 4	RXLEV-NCELL 5 (high part)	octet 13
RXLEV-NCELL 5 (low part)	BCCH-FREQ-NCELL 5 (high part)	octet 14
BCCH-FREQ-NCELL 5 (low part)	BSIC-NCELL 5	RXLEV NCELL 6 (high part) octet 15
RXLEV-NCELL 6 (low part)	BCCH-FREQ-NCELL 6 (high part)	octet 16
BCCH-FREQ-NCELL 6 (low part)	BSIC-NCELL 6	octet 17

According to one embodiment of the method according to the invention, both Ec/No and RSCP values are included in the Measurement Report. The 6 bits (below called B'0-B'5) in the RXLEV-NCELL n field are enough to include both relevant Ec/No values and relevant RSCP values, if a limited value range for each parameter is used.

Table 2: RXLEV-NCELL field

Reported value	Corresponds to Ec/No	Corresponds to RSCP (in ranges with 5 dBm steps)
B'0-B'5 = 000000-000111	-14 dB or	-110 or lower to –75 dBm or

	lower	higher
B'0-B'5 = 001000-001111	-13 dB	-110 or lower to –75 dBm or higher
B'0-B'5 = 010000-010111	-12 dB	-110 or lower to –75 dBm or higher
B'0-B'5 = 011000-011111	-11 dB	-110 or lower to –75 dBm or higher
B'0-B'5 = 100000-100111	-10 dB	-110 or lower to –75 dBm or higher
B'0-B'5 = 101000-101111	-9 dB	-110 or lower to –75 dBm or higher
B'0-B'5 = 110000-110111	-8 dB	-110 or lower to –75 dBm or higher
B'0-B'5 = 111000-111111	-7 dB or higher	-110 or lower to –75 dBm or higher

With this method the 6 bits can report the Ec/No values [–14 dB or lower; -13 dB; -12 dB; -11 dB; -10 dB; -9 dB; -8 dB; -7 dB or higher] and the CPICH RSCP values [-110 dBm or lower; -105 dBm; -100 dBm; -95 dBm; -90 dBm; -85 dBm; -80 dBm; -75 dBm or higher].

As a consequence, each reported value for Ec/No is reported together with one of eight different values or intervals for RSCP.

It is understood that each value is valid for a specific Frequency and Scrambling Code in the UTRAN/WCDMA network.

According to another embodiment of a method according to the invention, alternating Ec/No and RSCP values are included in the Measurement report

An alternative to the method is to order the user equipment 3 to report alternating Ec/No and RSCP values. The method of reporting, and reported quantity, can e.g. be indicated by using bits (/spare bits) in the Measurement Result message. This method could for instance be selected if the impact on the mobile terminal or user equipment implementation in the first method is high. With this method, the base station controller 10 keeps track of the values of both measured parameters, to be able to use both values in the handover evaluation.

FIG. 4 illustrates an embodiment of a user equipment according to the invention. The user equipment 3 is equipped with multi-RAT capabilities 30, e.g. GSM/TDMA and UTRAN/WCDMA. Further, the user equipment 3 comprises means 31 for measuring first and second (quality) parameters for neighboring UTRAN cells 20, and means 32 for reporting the measured parameters to a node such as a base station or base station controller 10 of a first network 1. In practice, the reporting means 32 are provided as part of an I/O unit.

The reporting means 32, according to a first embodiment, are adapted to report both parameters at the same time. According to another embodiment of a user equipment 3, the reporting means 32 are adapted to report the first and second parameters alternately.

In a preferred embodiment, the Measurement Result Report contains an indication whether the user equipment 3 can report Ec/No and RSCP simultaneously or alternating. This can for instance be implemented through a minor addition to the Classmark Change message specified in the 3GPP TS 04.18 and 24.008.

The implementations of this solution should be able to handle user equipment 3 that are unable to report both Ec/No and RSCP values i.e. backward compatibility has to be considered.

FIG. 5 illustrates a network node 4 in a first radio access network, e.g. a GSM network. The node 4 comprises means for receiving 40 measured first and second parameters from a multi-RAT user equipment, and means for selecting 41 a target UTRAN cell for potential handover in a UTRAN network. Finally, the node 4 is typically adapted to command the user equipment to switch to the selected target cell.

The receiving means 40, according to a first embodiment according to the invention, are adapted for receiving said first and second parameters at the same time.

According to said first embodiment, the selecting means 41 are adapted for selecting a target cell based on first and second parameters received at the same time. Preferably, said parameters are Ec/No and RSCP for a UTRAN cell.

Typically, the reporting means 40 are an I/O unit, which also is adapted to command the handover.

Preferably, the network node 4 is a base station controller or a base station in a GSM network 1.

According to a second embodiment, the receiving means 40 are adapted for receiving said first and second parameters alternately. Consequently, the selecting means 41 are adapted for selecting a target cell based on alternately received first and second parameters. Preferably, said parameters are Ec/No and RSCP.

A major advantage of this invention is that decisions on handover to UTRAN will be optimized. The decision will be more independent of the traffic load situation, and the implementation can be made in such a way that the operator can select to trigger GSM to UTRAN handover based on Ec/No measurements, RSCP measurements, or both.

The invention has primarily been discussed in the context of a handover of a dual-mode mobile terminal or user equipment from a GSM network to an UTRAN network.

However, the invention is equally applicable to handover from any type of network i.e. WLAN, CDMA2000 to a network utilizing WCDMA. Also, it is equally applicable to a multi-mode user equipment.

Since the basic idea of invention is general, it can also be applied in the evaluation of any radio network existing today or in the future.

It will be understood by those skilled in the art that various modifications and changes may be made to the present invention without departure from the scope thereof, which is defined by the appended claims.